# PATENT ABSTRACTS OF JAPAN

(11)Publication number : 10-151324

(43)Date of publication of application : 09.06.1998

(51)Int.Cl. B01D 53/94
B01D 53/86
B01J 35/02

(21)Application number : 08-312071

(22)Date of filing : 22.11.1996

(71)Applicant : BABCOCK HITACHI KK

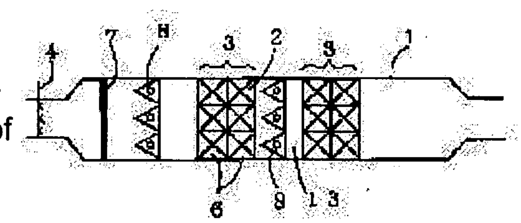
(72)Inventor : MORII SEIJI
MUKAI MASATO
WATANABE KO

## (54) FLUE GAS DENITRATOR

(57)Abstract:

PROBLEM TO BE SOLVED: To suppress the lowering of denitration performance by a denitration catalyst bed due to the nonuniformity of the gaseous NH3 distribution in a waste gas treating line.

SOLUTION: A denitration catalyst bed 3 consisting of a parallel-flow catalyst unit 6 obtained by laminating a honeycomb or plate catalyst element or a plurality of the catalyst blocks 2 obtained by laminating a plurality of the catalyst units 6 are arranged on the downstream side of an ammonia injection part 4 in a waste gas duct 1. At least two denitration catalyst beds 3 are set in the duct 1, a gap 13 is formed between the denitration catalyst beds 3, and a mixer 8 for mixing the waste gas and ammonia is set in the gap 13. The waste gas and NH3 are mixed at the inlets of the respective catalyst beds by the mixer 8 set in the gap 13, the unbalance of distribution of the molar ratio of NH3 to NOx is reduced, and the denitration performance is enhanced.




LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the exhaust gas denitrizer equipped with the denitrification catalyst bed which starts the denitrification plant which uses a reducing agent and a denitrification catalyst, especially raises a denitrification operation of a denitrification catalyst.
[0002]
[Description of the Prior Art] The nitrogen oxides (NOx) under smoke eliminating discharged from an electric power plant, various works, or an automobile are the causative agents of photochemical smog, and the exhaust gas denitrizer by alternative catalytic reduction is broadly used centering on the thermal power station as the effective removal approach. In recent years, in order that the amount of exhaust gas which contains NOx from development of industry may tend to increase and may observe environmental standards, it is in the situation that low NOx concentration-ization of the further exhaust gas will be required from now on. Moreover, to also stop very much CO concentration contained in a combustion gas besides NOx to a low is desired, and implementation of the denitrification catalyst for removing them and a process has been an important technical problem.
[0003] Especially when the denitrification catalyst of the titanium oxide system currently used for the exhaust gas denitrizer from the former was used, it is [ the following problems ] and was difficult to realize efficient denitrification which holds down NOx in the gas of an exhaust-gas-denitrizer outlet to the very low level below the NOx concentration (0.04 ppm) of 0.1 ppm or less or the atmospheric-air average.
[0004] ** the high concentration accompanying 1.0 or more mole ratios [ of NH3/NOx ] (it only abbreviates to a mole ratio hereafter) operation is unreacted -- NH3 discharges.
** there is the need of making a mole ratio into a value (1.2 or more [ for example, ]) quite higher than 1.0, and increasingly unreacted usually, since there is a difference (imbalance) of said local mole ratio in the exhaust gas passage region in front of a catalyst bed -- the concentration of NH3 becomes high.
** In order to lose the local difference of a mole ratio, the long duct for planning diffusive mixing of NH3 is needed, and bring about growing gigantic of a denitrification plant.
[0005] especially the imbalance (imbalance of NH3 concentration) of a mole ratio influences the denitrification engine performance greatly, and is unreacted -- it has led also to increase of NH3.
[0006] In order to control the imbalance of this NH3 concentration, the denitrification plant which installed the exhaust gas mixer 8 in the style side before the denitrification catalyst bed 3 in the offgas treatment system in the exhaust gas duct 1 as shown in drawing 15 is proposed. However, as shown in drawing 15 , after ammonia is poured in into an exhaust gas way from the ammonia impregnation nozzle 4 by the offgas treatment system and the mixed gas of ammonia and exhaust gas is rectified by the straightening vane 7, it is mixed with the exhaust gas mixer 8, and it is denitrogenized by the denitrification catalyst bed 3 which carried out the laminating of the catalyst block 2 with which the denitrification catalyst was contained.
[0007] Moreover, in order to make decline in the denitrification effectiveness by channeling of the mixed gas introduced into the inlet port of the denitrification catalyst bed 3 cancel, the denitrification plant which corrects said channeling is also proposed by preparing two or more denitrification catalyst beds 3, as shown in drawing 16 , and preparing a gap among each catalyst beds 3 and 3 (JP,4-82364,A, JP,54-82364,A). Mixer 10
[0008] moreover, the configuration which installed the straightening vane 12 for mixing the gas which leaked or more two spacing to the back-wash side of the denitrification catalyst bed 3 of the preceding paragraph in the denitrification reactor which opened the denitrification catalyst bed 3 as shown in drawing 17 and was formed is also proposed (JP,8-168652,A).

[0009]

[Problem(s) to be Solved by the Invention] With the above-mentioned conventional technique, although exhaust gas and NH3 are mixed at denitrification catalyst bed 3 inlet port, the imbalance (imbalance of NH3 concentration) of some mole ratios still exists. Said imbalance of denitrification catalyst bed 3 inlet port does the bad influence of succeeding the imbalance same in the denitrification catalyst bed 3 as it is, and has become the cause of reducing denitrification effectiveness. Moreover, when two or more denitrification catalyst beds 3 are prepared and a gap is prepared between each denitrification catalyst bed 3, channeling between the denitrification catalyst beds 3 is canceled, but an exhaust gas mixing operation is small, and in order to obtain sufficient mixing and to have to take said gap very greatly, the problem that a denitrification reactor is enlarged is also generated. The technical problem of this invention is to offer the exhaust gas denitrizer which can stop the denitrification performance degradation by the denitrification catalyst bed by the bias of distribution of NH3 gas in an offgas treatment system.

[0010]

[Means for Solving the Problem] The technical problem of above-mentioned this invention Two or more parallel flow mold catalytic units obtained by carrying out the laminating of the shape of a honeycomb and the tabular catalyst element or said catalytic units are accumulated. In the exhaust gas denitrizer which has arranged the denitrification catalyst bed which consists of two or more combination of the catalyst block acquired to the back-wash side of the ammonia impregnation section inside an exhaust gas duct Said denitrification catalyst bed is installed in [ at least two or more ] an exhaust gas duct, a gap is prepared between each denitrification catalyst bed, and it is solved by the exhaust gas denitrizer which installed the mixer which mixes ammonia with exhaust gas in this gap. According to this invention, while preparing a gap between two or more adjoining denitrification catalyst beds, a mixer is installed in each gap, NH3 is mixed with exhaust gas at the inlet port of each denitrification catalyst bed, and the imbalance of distribution within the exhaust gas duct of the mole ratio of NH3/NOx becomes small, and can raise the denitrification engine performance.

[0011]

[Embodiment of the Invention] The gestalt of operation of this invention is explained based on drawing. The side-face sectional view inside an exhaust gas denitrizer is shown in drawing 1 . In the exhaust gas duct 1, two or more denitrification catalyst beds 3 which consist of a configuration shown in drawing 2 are opened into an exhaust gas duct, respectively, spacing is arranged, NH3 impregnation nozzle 4 is formed in the style side before the denitrification catalyst bed 3, and the mixer 8 in which a perspective view is shown is formed over the whole cross section of a duct 1 at the straightening vane 7 which shows a top view to drawing 6 , and drawing 7 between the denitrification catalyst beds 3 of NH3 impregnation nozzle 4 and a first stage. Furthermore, although the denitrification catalyst bed 3 prepares or more two spacing and it is arranged, one or more mixers 8 are installed in spacing between the denitrification catalyst bed 3 over the whole cross section of a duct 1.

[0012] As shown in drawing 2 , the laminating of many tabular catalyst elements 5 is carried out, and the denitrification catalyst bed 3 of this invention forms the catalytic unit 6 of a parallel flow mold, and it fills up with it in the block frame 11, and it forms the catalyst block 2 so that it may be arranged up and down and further two or more catalytic units 6 may become length, width, and the range whose one side is about 1m - 3m. The catalyst element 5 is arranged so that it may become the direction of the gas by which the plate surface flows in the catalyst block 2, and parallel.

[0013] The catalyst element 5 is the thing of the shape of tabular [ which was calcinated and obtained ] or a honeycomb, after calcinating to the cancellous object which carried out the plain weave of the **** of for example, the fiber made from E glass, and applying a catalyst base material component with the denitrification activity which consists of TiO2, TiO2, MoO3, TiO2, WO3, etc.

[0014] As shown in drawing 3 , it covers with much catalyst blocks 2 in a duct 1 ( drawing 1 ) at the whole surface, and the denitrification catalyst bed 3 is formed by accumulating two or more steps of them further.

[0015] In this invention, as shown in drawing 5 , the seal plate 14 between units which has T typeface cross section is installed in the back end of the gap produced between the side faces of the catalytic unit 6 which installs the interblock seal plate 15 which has T typeface cross section in the back end (downstream of gas flow) of the gap produced between the side faces of the adjoining catalyst block 2, and adjoins it as shown in drawing 4 . The interblock seal plate 15 and the seal plate 14 between units have inserted in the gap the leg which falls from the bar of T typeface covering the gap overall length, respectively.

[0016] By the Prior art, flow is inhibited by the structure of the above denitrification catalyst bed 3 with the interblock seal plate 15 and the seal plate 14 between units, and, as for the unsettled exhaust gas which was flowing the gap during the catalyst block 2 and between catalytic units 6, without being denitrogenized, a gas leak decreases according to it. Furthermore, each seal plates 14 and 15 make a direction changed to the side which has the catalyst element 5 in

the exhaust gas which flowed into each gap during the catalyst block 2 and between catalytic units 6, and are mixed with the gas denitrogenized through the catalyst element 5. Since this mixed gas is denitrogenized in the next phase, each seal plates 4 and 5 reduce NOx in a denitrification catalyst bed outlet, and NH3, and make the denitrification engine performance of a catalyst bed improve after all.

[0017] If the denitrification reactor of the conventional technique shown in drawing 15 - drawing 17 is made into the example 1 of a comparison - the example 3 of a comparison, respectively In the example 1 of a comparison shown in drawing 15 , NH3 is sprinkled in exhaust gas from NH3 impregnation nozzle 4. Although NH3 is mixed with exhaust gas with the straightening vane 7 and the mixer 8 at the inlet port of the denitrification catalyst bed 3, it will pass to the outlet of the denitrification catalyst bed 3 in the condition as it is, and the imbalance of concentration distribution of NH3 produced at the inlet port of the denitrification catalyst bed 3 is reducing the denitrification engine performance.

[0018] Moreover, although two or more denitrification catalyst beds 3 were formed and spacing 13 is further formed between each catalyst bed 3 and 3 in the example 2 of a comparison shown in drawing 16 Although gas flow is laminar-flow-ized within the denitrification catalyst bed 3 and 3 and channeling is corrected in a catalyst bed 3 and the gap 13 between three, since the turbulence of the flow of the gas in the gap 13 is small, the mixed effectiveness of exhaust gas is small and the imbalance of concentration distribution of NH3 is not canceled.

[0019] Moreover, although mixed by the straightening vane 12 about the gas leaked from the clearance between the catalyst block 2 which constitutes the denitrification catalyst bed 3 from an example 3 of a comparison shown in drawing 17 , and the wall of a duct 1, there is no overall exhaust gas mixing effectiveness, and the dissolution of the imbalance of concentration distribution within the gas stream of NH3 is not carried out.

[0020] By forming two or more denitrification catalyst beds 3 by this invention to said example of a comparison, and on the other hand, installing a gas blender 8 in the gap 13 of each catalyst bed 3 and a catalyst bed 3 Promote the turbulence of the gas flow in the inlet port of each denitrification catalyst bed 3, and exhaust gas and NH3 are fully mixed. Imbalance of concentration distribution of NH3 within a duct 1 is made small, it is mixed with a mixer 8 and the unreacted exhaust gas leaked from the clearance between the catalyst block 2 which constitutes the denitrification catalyst bed 3 further, and the wall of the duct 1 of a denitrification reactor can also raise the denitrification engine performance.

[0021] Hereafter, a numeric value is shown concretely and effectiveness is described. The trial the effectiveness of this invention is proved [ trial ] was performed using the water plain stream mold denitrification testing device.
The ammonia impregnation nozzle 4 is formed in the inlet port of the water plain stream mold denitrification testing device 9 as shown in example 1 drawing 8 , the interior is further filled up with six cross-section 450mmx450mm catalytic units 6 of the direction which intersects perpendicularly to a gas flow direction, and a straightening vane 7 and a mixer 8 are installed in catalytic unit 6 inlet port of a forefront stage. The gap 13 which is like [ it constitutes one denitrification catalyst bed 3 at ~~a time from~~ two units, and a mixer 8 enters a catalytic unit 6 between each catalyst bed 3, respectively ] is formed, and a mixer 8 is installed there.

[0022] The example which applied ~~the~~ conventional technique of the example 1 of a comparison to the same water plain stream mold denitrification testing device 9 as said example 1 at example of comparison 1 drawing 9 is shown. The ammonia impregnation nozzle 4 is formed in the inlet port of the water plain stream mold denitrification testing device 9, it is filled up with six units of cross-section 450mmx450mm catalytic units 6 of the direction which intersects perpendicularly with the interior to a gas flow direction further, and the straightening vane 7 and the mixer 8 are installed in the inlet port of this denitrification catalyst bed 3.

[0023] Like the example 1 of drawing 8 , the water plain stream mold denitrification testing device 9 is used, and the example 2 of a comparison is shown in example of comparison 2 drawing 10 . The ammonia impregnation nozzle 4 is formed in the inlet port of the water plain stream mold denitrification testing device 9, one denitrification catalyst bed 3 is constituted, it fills up with two units at a time the cross-section 450mmx450mm catalytic unit 6 of the direction which intersects perpendicularly with the interior to a gas flow direction further, and a gap 13 is formed like the example 1 of this invention between each catalyst bed 3. And the straightening vane 7 and the mixer 8 are installed in the inlet port of the denitrification catalyst bed 3 of a forefront stage.

[0024] Like an example, the water plain stream mold denitrification testing device 9 is used, and the example 3 of a comparison of this invention is shown in example of comparison 3 drawing 11 . The ammonia impregnation nozzle 4 is formed in the inlet port of the water plain stream mold denitrification testing device 9, one denitrification catalyst bed 3 is constituted, it fills up with two units at a time the cross-section 450mmx450mm catalytic unit 6 of the direction which intersects perpendicularly with the interior to a gas flow direction further, and a gap 13 is formed like the example 1 of this invention between each catalyst bed 3. ~~And the straightening vane 7 and~~ the mixer 8 are installed in the inlet port of the catalyst bed 3 of a forefront stage. moreover, the ~~straightening vane 12 is~~ installed in the back-wash

side of each catalyst bed 3.

[0025] The example which used the water plain stream mold denitrification testing device 9 for example of comparison 4 drawing 12 for the example 4 of a comparison of this invention like the example 1 is shown. The ammonia impregnation nozzle 4 is formed in the inlet port of the water plain stream mold denitrification testing device 9, the single denitrification catalyst bed 3 filled up with six units of cross-section 450mmx450mm catalytic units 6 of the direction which intersects perpendicularly with the interior to a gas flow direction further is constituted, and a straightening vane 7 and three mixers 8 are put in order and installed in the entry of this denitrification catalyst bed 3.

[0026] Using the LPG combustion gas, on condition that Table 1, NH3 concentration and NOx concentration were measured, respectively and it traversed to five on the duct cross section of the point of measurement which shows the value to drawing 13 (NO.1-NO.5) at the A point of the inlet port of a catalyst bed 3 shown in drawing 8 - drawing 12 , the middle B point of a catalyst bed 3, C point, and D point of the outlet of a catalyst bed 3.

[Table 1]

| | | | |
|---|---|---|---|
| ガス温度 | ３３７℃ | 排ガス種 | ＬＰＧ排ガス |
| ＮＯｘ | ８８．８ppm | $NH_3$ | １０７ppm |
| モル比 | １．２ | 面積速度 | ７ｍ／ｈ |

[0027] The traverse result of each NOx concentration and NH3 concentration is shown in Table 2 (NOx concentration) and Table 3 (NH3 concentration), respectively with the A point of the inlet port of the denitrification catalyst bed 3 which shows a test result to drawing 8 - drawing 12 , a middle B point, C point, and D point of an outlet.

[Table 2]

NOx(ppm)

| | | NO. 1 | NO. 2 | NO. 3 | NO. 4 | NO. 5 | AVE |
|---|---|---|---|---|---|---|---|
| 実施例1 | A | 89 | 89 | 89 | 89 | 88 | 88. 8 |
| 実施例1 | B | 7 | 6 | 6 | 6 | 5 | 6 |
| 実施例1 | C | 0. 5 | 0. 3 | 0. 4 | 0. 6 | 0. 4 | 0. 44 |
| 実施例1 | D | 0. 02 | 0. 03 | 0. 02 | 0. 01 | 0. 01 | 0. 02 |
| 比較例1 | A | 89 | 89 | 89 | 89 | 88 | 88. 8 |
| 比較例1 | B | 6 | 4 | 6 | 9 | 5 | 6 |
| 比較例1 | C | 0. 8 | 0. 5 | 0. 7 | 1 | 0. 7 | 0. 74 |
| 比較例1 | D | 0. 06 | 0. 06 | 0. 05 | 0. 12 | 0. 05 | 0. 07 |
| 比較例2 | A | 89 | 89 | 89 | 89 | 88 | 88. 8 |
| 比較例2 | B | 6 | 4 | 6 | 9 | 5 | 6 |
| 比較例2 | C | 0. 8 | 0. 6 | 0. 7 | 0. 9 | 0. 7 | 0. 72 |
| 比較例2 | D | 0. 07 | 0. 07 | 0. 06 | 0. 09 | 0. 05 | 0. 07 |
| 比較例3 | A | 89 | 89 | 89 | 89 | 88 | 88. 8 |
| 比較例3 | B | 6 | 4 | 7 | 8 | 5 | 6 |
| 比較例3 | C | 0. 7 | 0. 6 | 0. 8 | 0. 8 | 0. 7 | 0. 72 |
| 比較例3 | D | 0. 07 | 0. 07 | 0. 07 | 0. 08 | 0. 05 | 0. 07 |
| 比較例4 | A | 89 | 89 | 89 | 89 | 88 | 88. 8 |
| 比較例4 | B | 6 | 4 | 7 | 8 | 5 | 6 |
| 比較例4 | C | 0. 8 | 0. 5 | 0. 8 | 0. 9 | 0. 7 | 0. 74 |
| 比較例4 | D | 0. 06 | 0. 06 | 0. 06 | 0. 11 | 0. 05 | 0. 07 |

AVE値；平均値(ppm)

[0028]
[Table 3]

$NH_3$(ppm)

| | | NO. 1 | NO. 2 | NO. 3 | NO. 4 | NO. 5 | AVE | CV値 |
|---|---|---|---|---|---|---|---|---|
| 実 | A | 114 | 111 | 100 | 108 | 101 | 107 | 5. 5 |
| 施 | B | 31 | 31 | 30 | 28 | 30 | 30 | 11. 9 |
| 例 | C | 20 | 20 | 18 | 16 | 16 | 18 | 12. 6 |
| 1 | D | 14 | 13 | 12 | 10 | 11 | 12 | 39. 4 |
| 比 | A | 114 | 111 | 100 | 108 | 101 | 107 | 5. 5 |
| 較 | B | 35 | 32 | 26 | 30 | 27 | 30 | 32. 7 |
| 例 | C | 22 | 23 | 20 | 17 | 18 | 20 | 36. 5 |
| 1 | D | 18 | 17 | 14 | 13 | 13 | 15 | 31. 8 |
| 比 | A | 114 | 111 | 100 | 108 | 101 | 107 | 5. 5 |
| 較 | B | 33 | 30 | 29 | 30 | 28 | 30 | 28. 1 |
| 例 | C | 22 | 22 | 19 | 19 | 18 | 19. 8 | 30. 5 |
| 2 | D | 16 | 16 | 15 | 14 | 14 | 14. 6 | 20. 5 |
| 比 | A | 114 | 111 | 100 | 108 | 101 | 107 | 5. 5 |
| 較 | B | 31 | 30 | 31 | 30 | 28 | 30 | 26. 9 |
| 例 | C | 21 | 21 | 20 | 19 | 19 | 20 | 18. 7 |
| 3 | D | 15 | 16 | 16 | 14 | 14 | 15 | 16. 7 |
| 比 | A | 112 | 111 | 102 | 108 | 101 | 107 | 4. 4 |
| 較 | B | 31 | 32 | 29 | 30 | 28 | 30 | 31. 3 |
| 例 | C | 21 | 22 | 21 | 18 | 18 | 20 | 32 |
| 4 | D | 17 | 16 | 15 | 14 | 13 | 15 | 26. 4 |

AVE値；平均値(ppm)

CV値；各測定位置でのﾓﾙ比変動係数(%)

[0029] According to the above-mentioned experimental result, the example 1 of a comparison has brought a result with a high coefficient of variation (variation) of the mole ratio of NH3/NOx in the middle B point of a catalyst bed 3, and C point under the effect of the variation in the mole ratio of the inlet port A of a catalyst bed 3.
[0030] Moreover, in the example 4 ( drawing 9 ) of a comparison which installed three mixers 8 in the style of before the denitrification catalyst bed 3, although the coefficient of variation of a mole ratio is decreasing a little in the inlet-port A point of a catalyst bed 3, there is said variation, and under the effect, said variation in the midpoint B point and C point of a catalyst bed 3 is high, and has still been the denitrification engine performance same as a result as the example 1 of a comparison.
[0031] In the example 2 of a comparison, although a few improves, by the time the variation in the mole ratio of the midpoint B point of a catalyst bed 3 and C point raises the denitrification engine performance from the case of the example 1 of a comparison, it will not have resulted.
[0032] Although mixed about the gas leaked in the example 3 of a comparison from the clearance between a catalytic unit 6 and the wall of the water plain stream mold denitrification testing device 9, gas mixture as the whole is not carried out, but the variation and the denitrification engine performance of a mole ratio are almost the same as that of

the example 2 of a comparison.
[0033] On the other hand, in the example 1, the variation in the mole ratio in the inlet port (catalyst bed midpoint B-C) of each catalyst bed 3 became small clearly, consequently more, the denitrification engine performance improved and the residual NH3 brought a result reduced.
[0034] That is, like this example, the imbalance of distribution of the mole ratio within a denitrification reactor was canceled, and arrangement formats, such as each catalyst bed 3 inside a denitrification reactor, a straightening vane 7, and a mixer 8, enabled it to consider as equipment with high denitrification effectiveness.
[0035] The example of others of this invention is shown in example 2 drawing 14 . the denitrification plant of catalyst arrangement form in which the space of the exhaust gas duct 1 exists between two denitrification catalyst beds 3 on the relation of an installation tooth space like drawing 14 -- it is, a mixer 8 is installed to the space of the exhaust gas duct 1 between the denitrification catalyst beds 3, and the denitrification engine performance is raised. Such arrangement can be nothing entirely in increase of a denitrification reactor, can improve the denitrification engine performance, and is a very effective method of utilizing this invention.
[0036]
[Effect of the Invention] According to this invention, with the conventional technique, two or more catalyst beds are prepared for the bad influence by the imbalance of distribution of denitrification performance degradation and NH3 concentration in the denitrification catalyst bed inlet port which had caused the increment in residual NH3. By preparing the gap which is like [ a mixer enters between these catalyst beds ], and installing a mixer there The exhaust gas which is not denitrogenized [ which mixed exhaust gas at each catalyst bed inlet port, and made imbalance of concentration distribution of NH3 small, and was leaked from the gap of a catalyst bed ] can also be mixed, the final NOx value of a denitrification reactor outlet and NH3 value can be decreased, and the denitrification engine performance of a denitrification reactor can be raised.

---

[Translation done.]